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## GUNNERA PETALOIDEA GAUD., A REMARKABLE PLANT OF THE HAWAIIAN ISLANDS

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A distinctive feature of the Hawaiian flora is the prevailing endemicity of the rain-forest species. About 85 percent of the flowering plants of the islands are endemic, and the bulk of these are characteristic of the rain-forest zone. This zone lies between the elevations of 2,000–6,000 ft. The mountains of Kauai, Oahu, East Molokai, West Maui, and the Kohala Range on Hawaii, rise to heights of 3,000–6,000 ft., and thus their summits are covered with dense rain-forest vegetation. The great valleys of erosion have eaten back into the very hearts of these mountain masses, so that the summit regions abound in knife-edged ridges and great precipices. Many of the summit ridges are only three or four feet wide at the crest; many of the precipices are 800–1,800 ft. high. The rainfall in these regions is torrential, and much of the vegetation is of the most pronounced hygrophytic type.

One of the most characteristic and conspicuous plants of these humid summit regions is the endemic halorrhagaceous *Gunnera petaloidea* Gaud.<sup>1</sup> In the little hanging valleys that abound in this zone, on the precipices as well as in the steep stream-beds, are masses of this titanic herbaceous-perennial. The gigantic leaf-blades are three to four feet in diameter, peltate on fleshy petioles two or more feet long.<sup>2</sup> The petioles arise from a creeping or erect rhizome, which is fleshy, green, and four or five inches in diameter. The huge crown of leaves springs from the apex of the rhizome. As the latter is often branched, the total mass of foliage was spread over an area of ten or twenty square feet, with a height of six or eight feet. In places where they have not been disturbed by the landslides that are common in these regions, these gigantic herbs often cover areas fifty to a hundred feet long and twenty or more feet wide, as on the upper slopes of a precipice, where they form a beautiful mural tapestry.

<sup>1</sup> See bibliography.

<sup>2</sup> The blades of the Chilean *G. manicata*, the largest of the genus, are 5–10 ft. in diam., on petioles of 6–7 ft.; these are used in Chile for tanning hides.

The rhizome is very soft, and can be severed by a single machete stroke. It contains a considerable quantity of crude starch, together with numerous conspicuous fibers. It frequently contains colonies of endophytic algæ. It is closely pressed to the wet soil, but is not subterranean; it roots freely along the entire undersurface. The older, naked portions of the rhizome are green and conspicuously marked with the large petiole scars. No bark is developed. The apical region, 18–24 inches long, is usually more or less erect, depending upon the situation; sometimes, as near a stream-bed, the rhizome stands erect to a height of three or four feet. The entire length of the rhizome is generally not over six or eight feet; its frequent branching and the decay of the older parts tend to separate an old rhizome into several shorter new individuals. This vegetative reproduction, quite similar to that of many ferns, is the common mode of propagation after the plant has once established itself.

The petioles are thick, fleshy, and curiously muricate; they are three to four inches in diameter, and two to four feet long. The broad, fleshy stipules, 1–1½ in. long, are adnate to the base of the petiole. The blade is orbicular or rounded-reniform. It stands at right angles to the petiole. Its attachment is peltate, but there is a broad, open, basal sinus. It is very thick and fleshy, and deeply rugose. Gray states that the blades are “1½–2 ft. in diam. when full grown”; Hillebrand, that they are “2–3 ft. in width”; both of these are underestimates, and evidently based upon the examination of herbarium material, rather than a knowledge of the plant in the field. Leaves that are fully expanded are commonly three to four feet in diameter, and Bryan records a diameter of five feet.

The blade is more or less conspicuously eight- to ten-lobed, the lobes being very shallow, rounded and coarsely dentate. On its upper surface the blade is covered with coarse, short hairs; the under surface has a strong network of prominent veins. There are five large veins, pedately arranged; the venation is dichotomous, and more or less hispid with short, coarse hairs. A variety *beta*, collected by the U. S. Exploring Expedition on Kauai, and described by Asa Gray, has nearly glabrous foliage, with “bracts ovate or oblong, 6–8 mm. long.”

The main flowering season is mid-summer, although there seems to be considerable variation. The panicles are terminal. The rachis is 2–3 ft. tall, hirsute and scabrous, branching from near the base, and

grooved. The branches or spikes are 4-9 inches long, undivided, crowded but lax and spreading; they are covered throughout with clustered or scattering sessile flowers. The bracts of the inflorescence are linear, scarious, 1-1½ in. long. The flowers are bisexual and not bracteolate. The calyx is globular with adnate tube; there are two lobes, one anterior and one posterior; these are persistent, each 1-2 mm. long, broadly ovate or triangular, with broad or truncate apex, denticulate or 3-toothed, with a raised line along the inner face. The petals are two, alternate with the calycine lobes and 2 or 3 times as long; cucullate, enclosing the stamens before anthesis; broadly ovate or cuneate, retuse, obscurely glandular on the back, thickish in texture, epigynous; tardily deciduous. The stamens are two, epigynous, opposite the petals; filaments very short; anthers large, about 2 mm. long, emarginate at each end, somewhat didymous, fixed by the base, introrse, the two cells opening longitudinally. Pollen grains four-lobed. Styles two, opposite the stamens, and nearly twice their length; linear-subulate, hispid, slightly united at the base. Ovary one-loculed, with a single anatropous ovule suspended from the summit of the locule. Drupes ovoid-globose, yellow, reddish or purple, 2-4 mm. long, crowned with the short and incurved calycine lobes; the calyx tube forming the fleshy sarcocarp; endocarp small in proportion; acheniform, lenticular, 3- or 4-angled, crustaceous. Seed conformed to the endocarp; testa very thin and delicate; embryo minute, near the hilar extremity of the fleshy and oily albumen, subcordate, the radicle superior.

Schindler's monograph of the Halorrhagaceae in Engler's *Pflanzenreich* contains the following detailed description of *petaloidea*:

"Statura maxima, metrali vel ultra; rhizomate crasso, haud stolonifera, folia subpauca rosulata apice procreante, ligulis chartaceis, glabris, ± 45 mm. longis, latissime ellipticis apice obtusis, pluries divisus induto, scapos floriferos complures axillares proferente.

"Folia maxima, petiolo validissimo, ± 0.6 m. longo, canaliculato, basi laxe piloso superne glabro vel glabrato, hinc inde aculeolis brevibus sueto fere punctiformibus instructo stipitata; lamina depresso reniformi sat latiore ac longa, latissime cordata, circuitu in lobos subaequales sueto 9 late rotundatos vel obtusos divisa, margine grosse crenata, dentibus junioribus apice apiculatis senioribus obtusis, supra plana nec prominenti-areolata, praeter nervos nervillosque supra perlaxe subtus densius pilis crassis conspersos glabra, usque as 0.5 m. lata mihi visi.

"Inflorescentia scapo crasso, lineatim angulato, arcuatim adscendente, brevis sed semper manifesto, juniore saltem dense pilis crassis conicis consperso elata, quam folia berior, ∞ flora, densior laxiorve, optime thyrsoida, apice breviter acuta,

$\pm 0.4$  m. longa, axi primario crasso, piloso, bracteis primariis conspicuis quidem sed tamen quam ramuli axillares multo brevioribus, linearibus, apice subrotundatis, glabris, integerrimis vel basin versus obscure denticulatis, 15 mm. vix excedentibus, ramulis basi brevissime sterilibus, suberectis, pilosulis, primum dense demum in florum statu ♀ elongatis laxius quaquaverse flores  $\infty$  gerentibus, usque ad 150 mm. longis mihi visis sueto brevioribus; flores sessiles, 5 mm. longi, glaberrimi; ovarium laeve, breviter lateque cylindricum, apice vix constrictum, minute 4-lineatum; sepala brevissima, late squamiformi-triangularia, apice acuminulata, 0.5 mm. longa; petala glabra, ex ungue brevi late lineari in laminam haud multo latiore, cucullatam, apice obtusam producta,  $\pm 2$  mm. longa; stamina quam petala sat breviora, crassa, antheris fere orbicularis, apice obtusis, laevibus, quam filamenta brevissima crassaque longioribus; styli crasse cylindrici apice acuti, dense papilloso-villosi.

"Bacca exsucca, globosa, laevis,  $\pm 2.5$  mm. diam. metiens."

The family Halorrhagaceae Schindler<sup>3</sup> comprises seven genera. The family includes aquatic and terrestrial perennial herbs of widely diverse habit; some are minute, others, like the Hawaiian species, are titanic in size. The flowers are small, axillary or in terminal racemes or panicles, bi- or uni-sexual, regular; sepals usually 4, petals usually 4 or 0; stamens 8, the outer opposite the petals, or 4, rarely fewer; ovary inferior, 1-4-loculed; each locule one-ovuled; fruit nut-like, often crowned by the calyx.

The representation and geographic distribution of the genera is as follows:

1. *Loudonia* Lindl.—3 species; Australia.
2. *Halorrhagis* Forst.—about 60 species; Australia, Tasmania, New Zealand, Chatham I., New Caledonia, Chile, Juan Fernandez, China, Lower India.
3. *Meziella* Schindler—1 species; Australia, aquatic.
4. *Laurenbergia* Berg.—18 species; Africa, Mauritius, Bourbon, Ceylon, East Indies, Java.
5. *Proserpinaca* L.—2 species; "Mermaid Weed"; North America, Canada to Guatemala, in standing and slow-running water.
6. *Myriophyllum* L.—36 species; "Parrot's Feather"; cosmopolitan, all continents, including Australia and many islands.
7. *Gunnera* L.

The last genus, *Gunnera*, was named in honor of Ernst Gunner, a Swedish bishop and botanist (1718-1773), who wrote a local flora. In *Gunnera* the leaves are radical, ovate or orbicular, and often gigantic. The flowers are perfect, or rarely imperfect monoecious or poly-

<sup>3</sup> Britton and Brown use the spelling Haloragidaceae, and include the genus *Hippuris*, making eight genera.

gamous; small, greenish, in simple or branched spikes or panicles, the staminate flowers on the upper branches; flowers often packed on a great cob-like spike; petals 2 or 3 or none; calyx none or with 2 or 3 lobes; stamens 1, 2, or 3; ovary 1-loculed, bearing 2 filiform styles; fruit a drupe; plants rhizomatous.

The geographical distribution of the known *Gunnera* species is as follows:

*Sub-gen. I. Milligania (Hook. f. emend.) Schind.*

1. *cordifolia* Hook. f.; Tasmania.
2. *monoica*; New Zealand, Chatham.
3. *mixta* Kirk; New Zealand.
4. *strigosa* Colenso; New Zealand.
5. *prorepens* Hook. f.; New Zealand.
6. *densiflora* Hook. f.; New Zealand.
7. *dentata* Kirk; New Zealand.
8. *arenaria* Cheeseman; New Zealand.
9. *hamiltonii* Kirk; New Zealand.

*Sub-gen. II. Misandra (Comm.) Schind.*

10. *lobata* Hook. f.; extreme S. America.
11. *magellanica* Lam.; high mountains of S. Amer., Colombian Andes, Chile, Patagonia, Ecuador, etc.; alpine.
12. *reichei* Schind.; Chile (1,800 meters elev.).

*Sub-gen. III. Pseudo-Gunnera (Oerst.) Schind.*

13. *macrophylla* Blume; New Guinea, Celebes, Java, Sumatra, Philippines, in high mountains.
14. *perpensa* L.; S. and E. Africa, Madagascar.

*Sub-gen. IV. Panke (Mol.) Schind.*

15. *petaloidea* Gaud.; Hawaiian Islands only.
16. *bracteata* Steud.; Chile, Juan Fernandez.
17. *glabra* Phil.; Chile, Juan Fernandez.
18. *pyramidalis* Schind.; Chile, Juan Fernandez.
19. *peltata* Phil.; Chile, Juan Fernandez.
20. *pilosa* Kunth.; Colombia and Ecuador, high mountains.
21. *boliviana* Morong; Bolivia.
22. *apiculata* Schind.; Bolivia, high mountains.

23. *rheifolia* Schind.; Peru.
24. *brephogea* Linden; Colombia and Ecuador.
25. *manicata* Linden; Colombia.
26. *berteroi*; Phil.; Chile, high mountains.
27. *chilensis* Lam.; Chile, high mountains.
28. *brasiliensis* Schind.; Brazil.
29. *vestita* Schind.; Chile.
30. *commutata* Blume; Chile.
31. *insignis* (Oerst.) DC.; Costa Rica.
32. *wendlandii* Reinke; Costa Rica.
33. *insularis* Phil.; Juan Fernandez.

It is extremely significant to note that *G. petaloidea* is one of a number of endemic Hawaiian plants that have very close affinities with the Andean flora. It has been suggested that at one time in the history of the Pacific there existed a land-bridge or its equivalent connecting the now-remote Hawaiian archipelago with the South American continent. Considerable evidence could be brought forth to substantiate this view.<sup>4</sup>

Some of the typical habitats of this remarkable herb are: Wai-ale-ale Swamps, Kauai (4,000–5,000 ft.); Ka-ala and Kona-hua-nui summit ridges on Oahu (2,500–4,000 ft.); Pele-kunu Pali, Molokai (3,000 ft.) East and West Maui mountains (3,000–5,000 ft.); and the Ko-hala Range of Hawaii (4,000–5,000 ft.). It is thus evident that the Hawaiian *Gunnera* occupies a distinct ecological zone—2,500–5,000 ft.—which in general is characterized by steep declivities and torrential precipitation. It is never known to occur above or below the limits of this zone, although its drupes could be easily carried by birds, and it has abundant opportunity to descend mechanically to the lower levels. A striking peculiarity for a plant of such magnitude is its strong “preference” for very steep slopes, upon which it maintains an apparently precarious footing. These slopes have the advantage of maximum illumination, but are constantly subjected to landslides. In many of the regions enumerated above, *Gunnera* forms a tapestry on inaccessible and nearly vertical cliffs. Field studies of *Gunnera* give the impression that it has attained a relatively static condition, with reference to range, and is neither markedly spreading nor losing ground.

<sup>4</sup> The ecology of *Gunnera* indicates that it has been a member of the Hawaiian flora for a very long period of time; it belongs to the primitive flora.

The Hawaiian name for this plant is *Apé* or *Apé-Apé*; so far as is known the natives did not utilize this plant in any way. Some of the Gunneras of other regions are used horticulturally to produce luxuriant foliage effects, for which purpose they are admirably adapted. The Hawaiian species has not been utilized in this way; it is associated only with the fog-swept precipices of Hawaii's beautiful rain-forests.

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